Altitude Chamber Experiences

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February 26, 2002

I recently attended a high-altitude training class and demonstration at Shaw AFB, SC. The course was sponsored by the FAA and the US Air Force and utilized the altitude chamber facilities at Shaw AFB, SC. Shaw AFB is located in Sumter, SC, approximately 35 miles east of Columbia, near the middle of the state. It is about a six-hour drive from Knoxville, TN.

A total of four people attended our class including Kevin Anderson of the Smoky Mountain Soaring Association, Dewayne Jenkins, a former member of the SMSA now living in Wilmington, North Carolina, and another pilot whose name I do not know. Kevin, Dewayne, and I are interested in doing high-altitude glider flying, while the other fellow needed the high altitude signoff for his job as a commercial pilot for a freight company based out of Atlanta Georgia. This training is required to act as pilot-in-command or crewmember of an aircraft, pressurized or not, whose flight altitude will exceed 24,000 feet MSL.

The course started about 8:30am and we had about six different presentations, each involving a different aspect of high-altitude flight. We covered the physics of the atmosphere, respiration and circulation, motion sickness, and oxygen systems. A lecture on importance of situational awareness, the hazards of channelized attention, and the causes and cures for spatial disorientation highlighted the lecture portion of the class. Finally, after lunch, we had the briefing for the chamber flight, followed by the chamber flight itself. We were on the road home by about 4:15pm the same day.

The basic idea of the altitude chamber is to provide a controlled environment to experience your individual reactions to different scenarios at high altitudes. The chamber is sealed and has large vacuum pumps capable of reducing the air pressure inside the chamber at rapid rates, effectively simulating a rapid climb in an unpressurized aircraft at a rate of 3000 feet per minute. Bleed valves allow even more rapid descent rates. We came down around 5000 feet per minute, which I'm sure could have been increased if we had wanted.

The chamber contains 16 seats each with its own primary and backup oxygen regulator consoles and intercom connections. Before getting into the chamber, we were issued beanies, helmets, oxygen masks, and hose couplers that we would need for the "flight." We were assigned seats that allowed each of us to easily observe two other students so that we could not only feel the effects of hypoxia ourselves, but see other's reactions to it as well.

Figure 1 – A view of the outside of the altitude pressure chamber at Shaw AFB, SC

Figure 2 - A view of the oxygen regulators and crew stations

A graph of the FAA mission profile that we experienced is shown below. The entire profile took about an hour, including the 30 minute pre-breathing of 100% O_2 to remove a portion of nitrogen from the bloodstream. Notice the rapid decompression, the hypoxia demonstration, and the night vision demonstration.

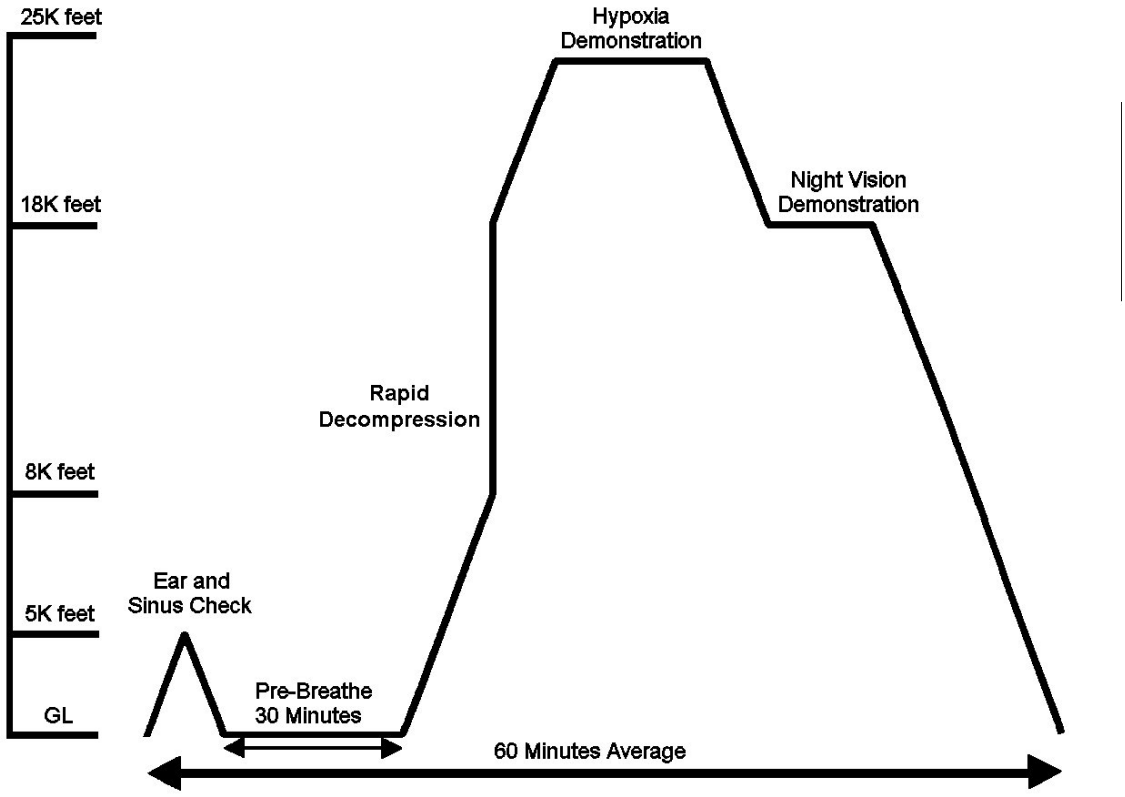

Figure 3 - Profile showing altitude versus time for the FAA chamber ride

The ear and sinus check was straightforward, having been sealed in the chamber and the air inside evacuated until a pressure altitude of 5,000 feet was reached. The reason for this brief check was to see that each student would be able to clear their ears properly and no sinus problems existed.

After returning to sea level, the door was again opened and we were instructed to not take off our masks for the next 30 minutes while we breathed 100% pure oxygen. Doing so would void our chance to continue the ride, as the introduction of any additional nitrogen into our bloodstream during this period could increase our chances of having decompression sickness afterwards.

This brought up an interesting point during the classroom discussion: It was generally advised that prior to any flight above 18,000 MSL in an unpressurized aircraft, the pilot would do well to pre-breathe 100% oxygen for at least a half-hour prior to the flight to help prevent decompression sickness. In any event, the use of canulas alone above 18,000 was strongly discouraged. The recommendation was to use a well-sealed facemask with either a continuous flow or demand system when flying at or above 18,000.

The instructor was right; this was the most boring part of the whole ride. They showed two FAA videos on aircraft pressurization systems and decompression hazards to help pass the time. When the lights finally came on, we were ready to begin.

The door was again sealed and masks remained on until the chamber was pumped down to a pressure altitude of 8,000 feet. We were then instructed to remove our masks and leave them off while the chamber was rapidly decompressed to a pressure altitude of 18,000 feet.

There was not a whole lot of excitement in this portion of the ride, except to keep our ears cleared using a combination of hard swallowing and the valsalva technique. The valsalva technique works well and is a good thing to use if swallowing doesn't work to clear the ears. To do it, pinch your nostrils shut, close your mouth, and very carefully pressurize the inside of your mouth. Not too much or you can hurt your ears. A little practice will help you find the right amount.

I suspect in the event of an actual rapid or explosive decompression onboard an aircraft, things wouldn't be quite as benign…

Once at 18,000 feet, the pressure altitude was leveled off for one to two minutes while we got our ears in shape and put our oxygen masks back on. After everyone was ready the pressure altitude was increased to 25,000 feet.

Now the fun part! Once we had leveled off at 25,000 feet, we removed the oxygen masks and began the hypoxia demonstration. We had to reach below our feet and find a clipboard that contained a hypoxia worksheet. This had several tasks that got progressively harder to complete as the time wore on. I signed my name, then checked for any of the listed hypoxia symptoms, which there were none at the time. I then tried whistling, but really couldn't hear much… I blamed it on the bulky helmet I was wearing!

Next came the math problems like "What's your age plus your weight?" and "What's your age plus your weight plus the pressure altitude your at right now?" I got both of these right, as well as one of the more conventional math problems like 9 x 4. I then went for the long-division problem and worked through almost of it and WHAM!

The symptoms started coming on very quickly… I noticed a bit of tingling in my arms, and some lightheadedness. I definitely got the feeling that something wasn't right, and then I got a little dizzy. My first inclination was to reach for the oxygen mask because I had a feeling like things were getting out of control. Which is good…

I was off O_2 for about 2 minutes and the first of the four folks to go back on. Kevin remained off for 4 minutes, while Dewayne remained off for 6 minutes. Kevin had a pulse-oximeter with him and made readings while he and Dewayne were off O_2. His oxygen saturation reached a low of 66%, while Dewayne's got down to 60%. I was unable to measure my O_2 saturation.

An interesting point about Dewayne is that he is an avid mountain climber and climbed Mt. Ranier this past August in Washington State. He is in pretty good shape and more accustomed to breathing at higher altitudes than most. My performance was not nearly as good, having to go back on oxygen after 2 minutes as opposed to his 6 minutes. I also, admittedly, do not get enough regular exercise, although I do try and eat a balanced diet. I will use this as an excuse to start a regular exercise program and revisit the chamber in 6 months to 1 year to see if I can improve my performance with the mask off at 25,000 feet. I'll keep you informed.

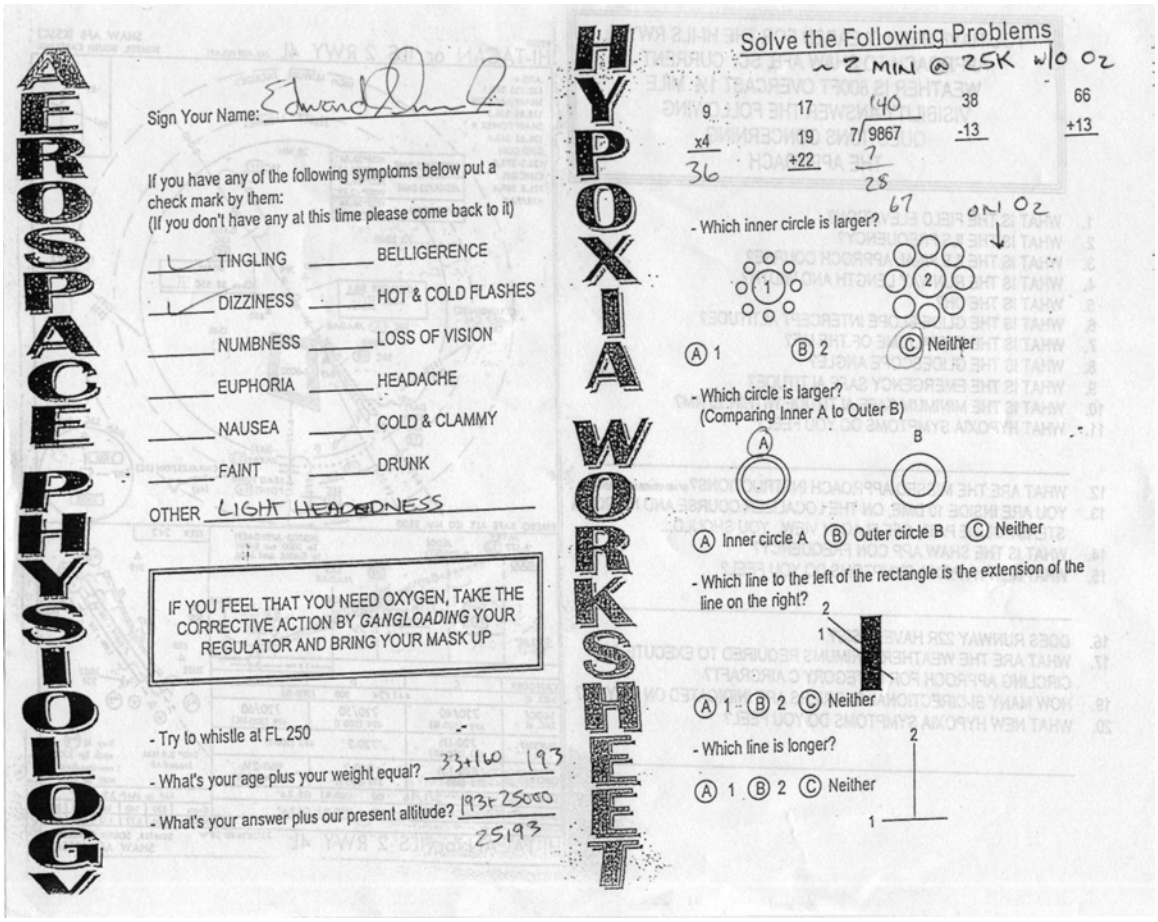

Figure 4 - Ed's Hypoxia Worksheet

There were two assistants who were always on oxygen who were ready to take care of any problems the trainees may have had in the chamber. They had some neat stories… Apparently it is not often, but some people do get sick in the chamber (a real mess, they say) and others can start hyperventilating.

Since the symptoms for both hypoxia and hyperventilation are nearly identical, both are treated the same way. The treatment: Grab the oxygen and very consciously control your breathing rate by counting 1001, 1002, breathe, 1001, 1002, breathe… The trick is that YOU have to consciously do this… No one can do it for you! The oxygen regulators had built in "blinkers" that rotate between white and black when you inhale and exhale to give a visual indication of your respiration rate. Luckily none of the folks in the chamber hyperventilated.

After 6 minutes of fun at 25,000 feet, when everyone was back on oxygen, we began a descent back to 18,000 feet. Upon reaching 18,000 the lights in the chamber were dimmed and red floodlights turned on. The idea was to simulate a dark cockpit on a night flight.

The assistants then passed out a color wheel chart, much like the one shown below:

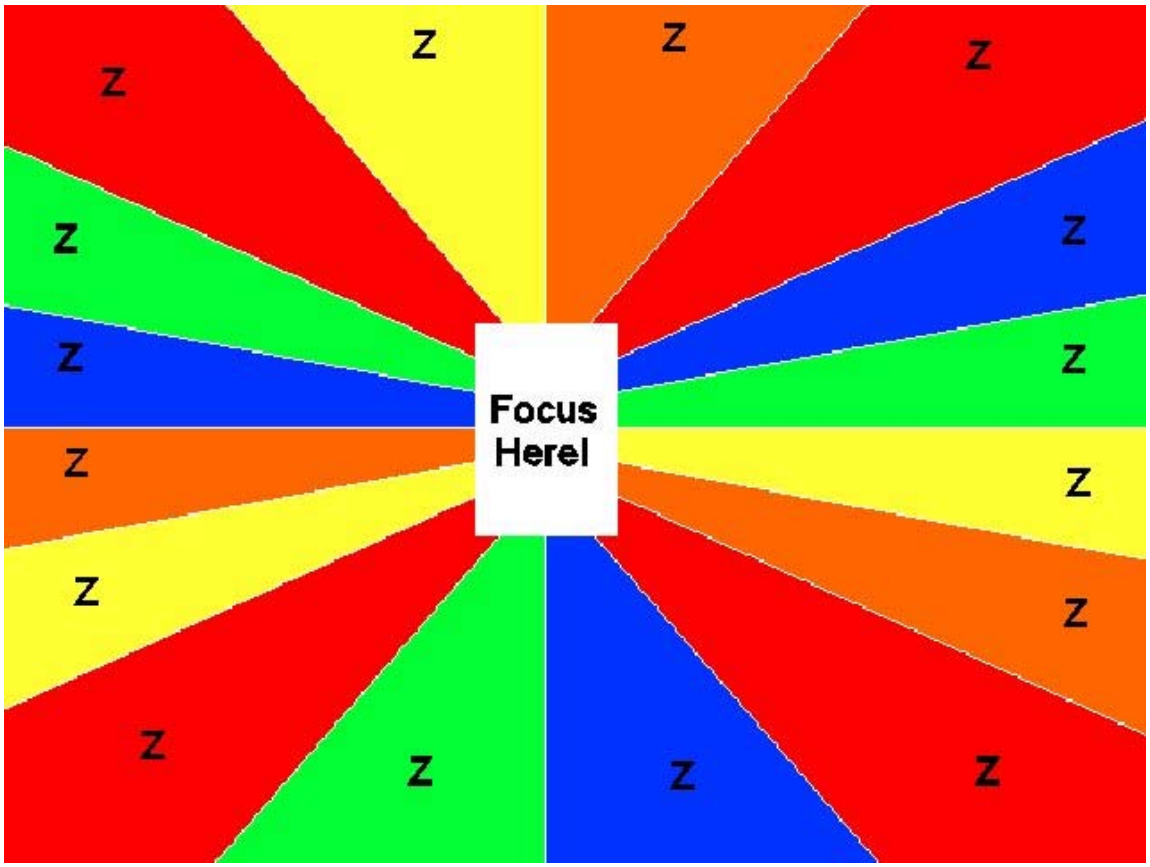

Figure 5 – Color wheel chart used for the night hypoxia demonstration

We were instructed to remove our masks once again and focus our eyes on the color wheel for a few seconds, then to look around the chamber and notice any colored items that we could see. There were lots of stickers on the chamber from the multitude of different military squadrons that had been there before us, all of them very colorful, as well as several bright yellow emergency O_2 tanks mounted to the walls. Then it was time to turn the color wheel over and stare at the Atlanta sectional chart that had been reproduced on the back for us. I took careful note, as the instructor mentioned, of the yellow colors around the densely populated city of Atlanta, the magenta rings around the multitude of GA airports, the blue lakes, the blue terrain, the lines drawn on the chart representing a course in a darker, sort of indistinguishable color.

Next, it was back to the color wheel and time to stare at the center spot for a few more seconds. By this time we had been off of O_2 for about 2 minutes and I was still feeling good about my ability to distinguish the colors on the color wheel… There were some darker blues and lighter blues, some color that may have been, yes, it was green… I think… But it was a darker color and I could still tell that from the other shades of colors, so I felt I was doing pretty well.

Then we were told to put on our oxygen masks while staring at the color wheel… WOW! One breath was all it took to make any possible confusion about what colors were in that wheel go away! The reds were the color that jumped out first, followed quickly by the greens and blues and yellows. Amazing! I then turned the card over and looked at the sectional… That too was amazing! The magentas were real magenta, the blues were real blues, the yellow was real yellow, and the ground was really green! Cool!

After sitting in amazement for a few seconds after putting the O_2 mask back on in the dark cockpit at 18,000 feet, I learned a valuable lesson about oxygen use while flying at night… If the colors

in things start to blend together and become indistinguishable, reach for the oxygen! It will bring the colors back to life in one breath!

One other thing to remember is that at 18,000 feet, the Time Of Consciousness (TOC) for most folks is about 20-30 minutes, meaning that most can be off oxygen (without strenuous activity or rapid decompression) for up to a half hour before passing out. Strenuous activity and/or rapid decompression will generally cut the TOC in half. But we experienced the first signs of hypoxia at 18,000 feet within 2 minutes while sitting in our chairs, staring at different colors in the dark. With my oxygen mask off for 2 minutes at 18,000 feet I felt none of the symptoms I felt at 25,000 feet.

As the lights came on and the chamber started refilling with air, we were all excited and talking about how neat the night vision hypoxia demonstration was, when all of a sudden I felt a sharp pain near the top of my nose and my right eye. I remember being told earlier that in case of problems, give the signal to level off by moving your hand back and forth horizontally in front of you. I did this and the instructor immediately stopped the descent and started an ascent. After going up about 1,500-2,000 feet, the pain went away.

At that point I needed to do the things they had told us about in the briefing that I hadn't really paid attention to thinking, "I feel fine, that won't happen to me!" Turns out one remedy for the acute sinus pain suffered during a descent is to stop the descent, take the oxygen mask off and tilt your head straight back. Use 2 shots of Afrin in both nostrils, let the stuff run back and make a terrible taste in your mouth, then lean your head forward between your legs and let it run toward the roof of your mouth. We hovered at about 12,000 for a minute while I caught my breath and waited to feel a little more comfortable. We then started the descent again. I got another powerful shot of pain about 5,000 feet, so the process was repeated again. Resuming the letdown at 3,000 feet per minute was the right descent rate to get me back to sea level, pain free.

The best part about learning how to deal with the sinus headache was being able to call a halt to the descent, treat the pain, and then continue on down… The last time I had a serious sinus pain during a descent was in a commercial airliner that was being slam-dunked into LAX. Unfortunately, the pain started during the initial part of the descent and was almost unbearable by the time we landed. Since it is hard to call a halt to the descent in that case, I'll always carry a bottle of Afrin with me on commercial flights from now on!

Wow! What a ride! Returning to sea level, I have a new appreciation for the upper atmosphere and just how valuable oxygen is, even when you don't think you really need it! This chamber is a really cool piece of equipment that is used for a lot more than just exposing civilian pilots to the hazards of high altitude flight.

Built in 1952, the chamber at Shaw has "flown" more than 35,000 people. It weighs 52,000 pounds, most of which is solid steel, to withstand the repeated pressure cycling the chamber must endure. The instructor joked that if the base were ever hit by a tornado, the chamber would be the place he would ride it out! We got a chance to poke around it a bit before the demonstration and look at a few of the other altitude profiles that are flown on a regular basis for military crews. The range of applications is quite amazing.

Pilots who fly fighters like the F-16 go through more aggressive altitude profiles that go up to 45,000 feet and have a few more plateaus than the training we had. Aircrews who have been deploying food rations over Afghanistan were qualified in these chambers, as well. They must physically exert themselves in the unpressurized cabin of a C-130 with the rear cargo door open at 25,000 feet to deploy the cargo palettes out the back. Of course, they each have individual oxygen masks and must be aware of how they will react should their oxygen supply be compromised while they are throwing things out the back of a loud, cold, windy airplane.

Skydivers, in particular the HALO (High-Altitude, Low Opening) folks who must free-fall out of an airplane at 25,000 feet with a bail-out bottle and pull the rip-cord somewhere around 2000 feet

AGL all the while maintaining their orientation and situational awareness while enduring the rapid pressure changes of this free-fall… at night… are qualified in these chambers.

The max altitude that this particular chamber can go is somewhere around 75,000 feet, which makes it ideal for training folks who fly planes like the U2 that require full pressure suits. These pressure suits at altitude blow up like big balloons and make movement quite difficult for the occupants. But it is better to find out how to deal with it in the safety of a chamber on the ground as opposed to the hostile cockpit at 70,000 feet.

So how do I sign up? First, you need to have a valid FAA medical (3rd class or better will do) and $50.00 (bargain, eh?). Call the folks at the Civil Aerospace Medical Institute in Oklahoma City, OK (Jim at 405-954-6207) and he can sign you up. The classes are offered once a month and there is room for 16 students at Shaw. You should allow at least 3 weeks for the paperwork to be processed, which has to be sent from OKC to you, and back to OKC with your payment, and from OKC back to you with the confirmation information. There is a long list of items that must be satisfied before being allowed to take the chamber flight, including not having done any SCUBA diving in the past 24 hours, not having had any alcohol within 12 hours, not having any known sinus problems or be taking any medication. Be sure to bring some Afrin, just in case!

Figure 6 - Kevin and Ed after getting back from 25,000 feet!

Figure 7 - Dewayne looks like a cool pilot!

Figure 8 - Kevin looks like a cool pilot, too!